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## NEW RECORDS OF STORKS (CICONIIDAE) FROM QUATERNARY ASPHALT DEPOSITS IN CUBA

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**Abstract.** Storks were previously known in Cuba only from the living Wood Stork (*Mycteria americana*)

and two bones of the extinct species *Ciconia maltha* from Cienfuegos Province. Newly explored Quaternary tar seep deposits in Matanzas Province have yielded fossils of *M. americana*, the extinct wood stork *M. wetmorei*, and an unidentified species of *Ciconia* smaller than *C. maltha*. These specimens provide the first verifiable fossil record of *M. americana* anywhere, the first of *M. wetmorei* outside of Florida and Cali-

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fornia, and the first instance of these two species occurring sympatrically.

**Key words:** *Ciconia*, Cuba, fossil birds, *Mycteria*, Quaternary, storks.

#### Nuevos Registros de Cigüeñas (Ciconiidae) en Depósitos Cuaternarios de Asfalto en Cuba

**Resumen.** Las cigüeñas eran conocidas en Cuba solo por la cayama viviente, *Mycteria americana*, y por dos huesos de la especie extinta *Ciconia maltha*, procedentes de la Provincia de Cienfuegos. La exploración de depósitos cuaternarios de asfalto en la Provincia de Matanzas, aportó fósiles de la cigüeña extinta *Mycteria wetmorei*, de *M. americana*, y de una especie no identificada de *Ciconia*, menor que *C. maltha*. Estos fósiles suministran el primer registro confiable de *M. americana*, y el primero de *M. wetmorei* fuera de Florida y California, junto con la primera evidencia de estas dos especies viviendo en simpatría.

Storks are represented in the modern avifauna of the West Indies only by the Wood Stork (*Mycteria americana* Linnaeus), in Cuba and Hispaniola (AOU 1998, Raffaele et al. 1998). This is also the only species resident in North America, although the fossil record shows that storks were more diverse there in the Pleistocene and earlier (Brodtkorb 1963, Short 1966, Becker 1987, Bickart 1990, Emslie 1998, Olson and Rasmussen 2001).

Hitherto, the only fossil record of storks for Cuba or the West Indies was based on two specimens from a spring deposit, Baños Termales de Ciego Montero, in the province of Cienfuegos, Cuba. These were originally identified by Wetmore (1928) as a Jabiru (*Jabiru mycteria*). The specimens were re-examined by Howard (1942) in a thorough revisionary work and assigned to the extinct species *Ciconia maltha* Miller (1910), which Howard also showed to occur in Pleistocene deposits in California, Idaho, and Florida.

Here we document the first fossil record for three additional species of storks from Cuba. These are all from asphalt deposits at Las Breas de San Felipe, Province of Matanzas, 5.5 km west of the town of Martí, (ca. 22°57'N, 80°58'W; X502, Y347 on the Martí map [Instituto Cubano de Geodesia y Cartografía 1986]). These deposits are of Quaternary age, probably late Pleistocene or early Holocene. Bones come from two sublocalities, San Felipe I and II, about 100 m apart. See Iturralde-Vinent et al. (2000) for a more complete discussion of the geology of the deposit, associated fauna, and age.

#### SYSTEMATIC PALEONTOLOGY

Order Ciconiiformes  
Family Ciconiidae  
*Ciconia* sp.

**Referred material.** Distal end of right tibiotarsus (MNHNCu P4599; Fig. 1E), collected by William Suárez and Stephen Díaz-Franco at San Felipe I, C area, 25 February 2001.

**Comparisons and remarks.** Distinguished from *Mycteria* by the characters discussed by Olson (1991), especially the width of the intercondylar sulcus as seen in distal view (Fig. 1D, E). The distal width of the fossil is 15.4 mm, which is smaller than that in the extinct *Ciconia maltha* (18.0–21.5 mm,  $n = 25$ ; Howard 1942) or the Maguari Stork, *Ciconia maguari* (17.1–19.6,  $n = 5$ ), the only extant species of *Ciconia* in the New World. It is about the size of the European White Stork, *Ciconia ciconia*, but it is otherwise insufficient for specific determination.

Various fossils of storks from North America, ranging in age from possible middle Miocene to late Pleistocene, have been referred to *Ciconia* (Becker 1987, Bickart 1990, Emslie 1998, Olson and Rasmussen 2001). Many of the Quaternary fossils have been referred to *Ciconia maltha* following Howard's (1942) revision, but trends in size variation through time, as well as sexual dimorphism, makes analysis of species limits in fossil *Ciconia* difficult (see Emslie 1998). The fossil recorded here increases the known species diversity of storks in Cuba but its biogeographical significance will have to await the discovery of better material.

Wood Stork, *Mycteria americana* Linnaeus, 1758

**Referred material.** Scapular portion of left coracoid (MNHNCu P4600); proximal end of right carpometacarpus (MNHNCu P4601; Fig. 1A), collected at San Felipe II, 24 February 2001 by William Suárez and Stephen Díaz-Franco.

**Comparisons and remarks.** The material agrees with *Mycteria* and differs from *Ciconia* by having coracoid with the medial surface of the acrocoracoid flat, rather than inflated; the carpometacarpus with a large proximal symphysis, the internal carpal trochlea bending less externally, anterior carpal fossa shallow, and metacarpal I very excavated on both sides. The specimens agree in size and qualitative characters with *M. americana*, and differ from *M. wetmorei* only in their lesser size (Table 1). We also encountered in the private collection of Oscar Arredondo (OA) a femur of *M. americana* lacking the distal end (OA x-2971) from an archeological site named El Mango, in Granma Province, collected by members of the Instituto de Arqueología, Academia de Ciencias de Cuba (Cordova and Arredondo 1988). This documents the presence of the Wood Stork in Cuba in pre-Columbian times.

All previous fossil records of Wood Stork in North America were shown to be based either on grossly misidentified bones or on those of the extinct species *Mycteria wetmorei* (Olson 1991). Emslie (1998) overlooked this reference and listed *M. americana* but not *M. wetmorei* as occurring in the late Pleistocene to Holocene of Florida. Therefore, the specimens of *M. americana* from Las Breas de San Felipe appear to constitute the only verifiable occurrence of this species in the fossil record.

*Mycteria wetmorei* Howard, 1935

**Referred material.** Proximal end of right carpometacarpus (MNHNCu P4602; Fig. 1C), collected 24 February 2001 by William Suárez and Stephen Díaz-Franco at San Felipe II. Distal end of right tibiotarsus (MNHNCu P4603; Fig. 1D); proximal end of left tar-

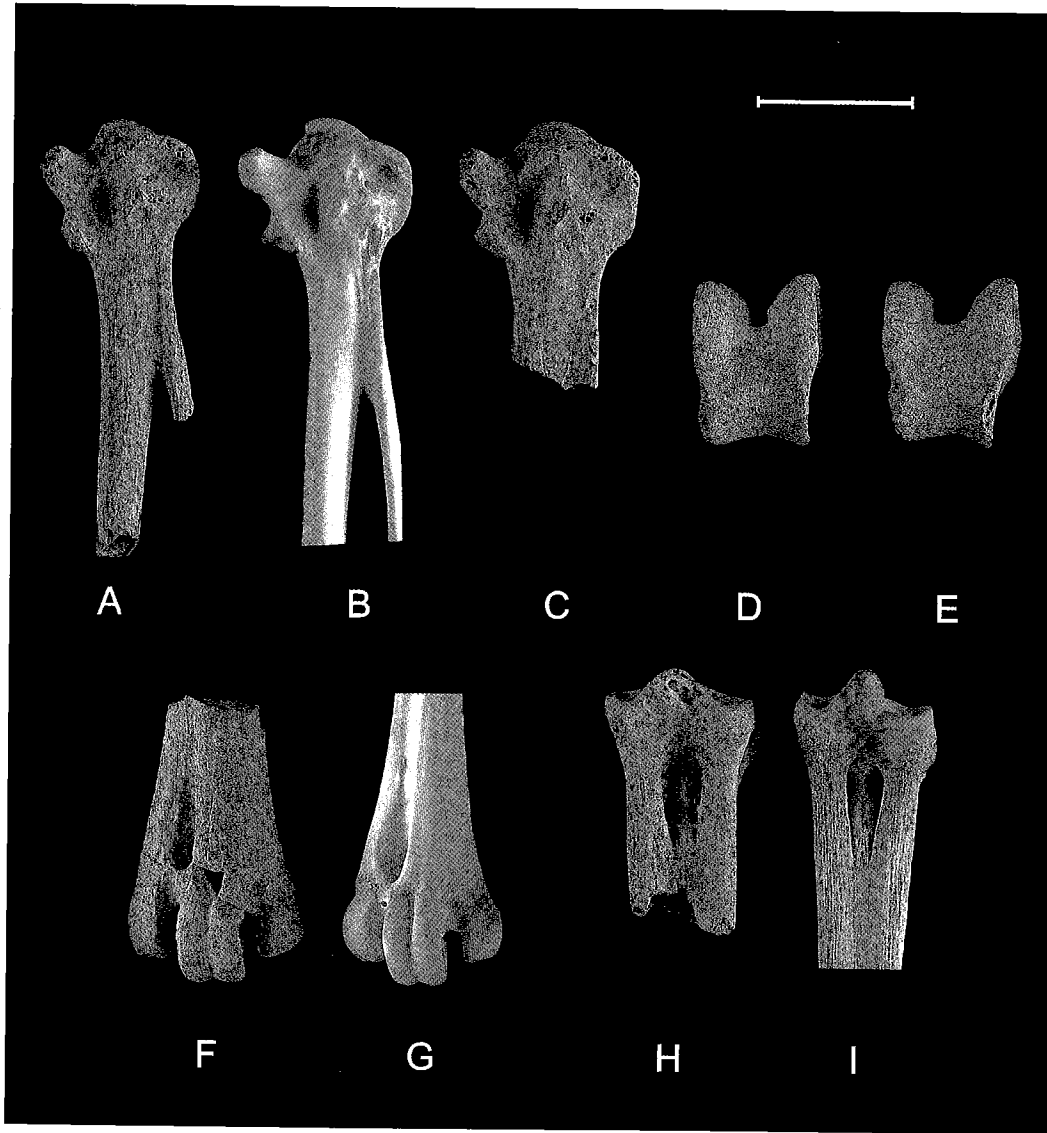


FIGURE 1. Fossil storks (A, C–F, H) from asphalt deposits in Cuba compared with the modern Wood Stork (*Mycteria americana*; B, G, I). A, proximal half of right carpometacarpus, internal view, of fossil *M. americana* (MNHNCu P4601); B, equivalent bone from modern *M. americana* (USNM 500884); C, proximal end of right carpometacarpus, internal view, of *M. wetmorei* (MNHNCu P4602); D, distal end of right tibiotarsus, distal view, of *M. wetmorei* (MNHNCu P4603); E, distal end of right tibiotarsus, distal view, of *Ciconia* sp. (MNHNCu P4599); F, distal end of right tarsometatarsus, anterior view, of *M. wetmorei* (MNHNCu P4605); G, equivalent bone from modern *M. americana* (USNM 50084); H, proximal end of left juvenile tarsometatarsus, anterior view, of *M. wetmorei* (MNHNCu P4604); I, equivalent bone from modern *M. americana* (USNM 559317, juvenile). Scale = 2 cm.

sometatarsus (juvenile; MNHNCu P4604; Fig. 1H); distal end of right tarsometatarsus (MNHNCu P4605; Fig. 1F); collected 25 February 2001 by William Suárez and Stephen Díaz-Franco at San Felipe I, C area.

*Comparisons and remarks.* The carpometacarpus (MNHNCu P4602) is referable to *Mycteria* as opposed

to *Ciconia* by the characters mentioned under *M. americana* and the tibiotarsi by the characters given by Olson (1991), which include the diagnostic incision at the proximomedial margin of the external condyle in anterior view (figure 1b of Olson 1991) and the narrow intercondylar sulcus in distal view (Fig. 1D). In *Ci-*

TABLE 1. Measurements (mm) of fossils of *Mycteria* from Cuba compared with modern skeletons of *M. americana*.

Measurement	<i>M. wetmorei</i>	<i>M. americana</i> Cuban fossils	<i>M. americana</i> modern		
			Range	Mean	<i>n</i>
Coracoid					
Depth at level of midpoint of glenoid facet	—	14.9	13.4–15.8	14.9	15
Width at level of midpoint of coracoidal fenestra	—	7.6	7.3–8.4	7.8	15
Carpometacarpus					
Depth from pollical facet to ventral edge of inner carpal trochlea	17.9 <sup>a</sup>	16.4	15.3–17.8	16.5	17
Tibiotarsus					
Distal width	14.7 <sup>a</sup>	—	12.2–14.1	13.2	31 <sup>b</sup>
Tarsometatarsus					
Proximal width	17.7 <sup>c</sup>	—	15.1–17.8	16.4	17
Distal width	21.3	—	17.4–20.6	19.1	17

<sup>a</sup> Abraded.<sup>b</sup> From Olson (1991).<sup>c</sup> Juvenile.

*conia* the incision is absent and the intercondylar sulcus is very wide (Fig. 1E). The tarsometatarsus agrees with that of *Mycteria* in having the distal portion more abruptly flared, with the shaft less anteroposteriorly compressed, and in distal view the outer trochlea is much more posteriorly situated than in *Ciconia*.

All of these fossils are similar to *M. americana* except in their much larger size, which is in agreement with *M. wetmorei* (Table 1), a species that was previously known only from California and Florida (Olson 1991). The Cuban fossils provide the first evidence of *M. wetmorei* outside of continental North America, and this is the first instance of the species occurring sympatrically with *M. americana*. This provides additional confirmation of the distinctiveness of *M. wetmorei*, which, in addition to its larger size, had the mandible less curved than in *M. americana* (Howard 1935). In both features it is more similar to the Old World species *M. leucocephala* (Olson 1991).

Olson (1991) hypothesized that *Mycteria wetmorei* may have been the original representative of the genus in North America and that *M. americana* may have colonized from South America subsequent to the extinction of the larger species. This could still be the case, although the Cuban occurrences show that the two species did once come together and coexist, which is perhaps not too surprising considering that biogeographically Cuba is something of a meeting ground between North America and the tropics.

#### DISCUSSION

The tar seeps at Las Breas de San Felipe provide the first good representation from Cuba of prehistoric birds from open and aquatic environments, as these are seldom preserved in the cave sites that have yielded the bulk of Cuban fossil vertebrates to date. This is particularly exemplified by storks, no fossils of which have ever been found in a Cuban cave. The tar seeps

have now doubled the diversity of storks known from the island.

The two species of *Mycteria* would have occupied aquatic habitats, as the storks of this genus feed almost exclusively in water using a tactile method known as the "bill-snap reflex" (Kahl and Peacock 1963, Kahl 1971). The two species of *Ciconia*, on the other hand, forage in open upland areas as well as aquatic situations and take various invertebrates and smaller vertebrates. Thus, they would have supplied an additional element to the huge roster of predatory birds that is now accumulating in the fossil record of Cuba.

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